Linear Regression 实验报告

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一、数据处理

本次数据集为 Boston House Price 数据集，房价影响因素及房价

通过sklearn.datasets获取数据

```
boston = load_boston()
x,y = boston.data,boston.target
```

查看数据大小：

```
print(x.shape)
print(y.shape)
```

```
(506, 13)
(506,)
```

数据共506项，数据集有13种影响因素

查看部分数据：

```
for i in range(7):
    print(x[i],'   ',y[i])
```

```
[2.7310e-02 0.0000e+00 7.0700e+00 0.0000e+00 4.6900e-01 6.4210e+00
 7.8900e+01 4.9671e+00 2.0000e+00 2.4200e+02 1.7800e+01 3.9690e+02
 9.1400e+00]     21.6
[2.7290e-02 0.0000e+00 7.0700e+00 0.0000e+00 4.6900e-01 7.1850e+00
 6.1100e+01 4.9671e+00 2.0000e+00 2.4200e+02 1.7800e+01 3.9283e+02
 4.0300e+00]     34.7
[3.2370e-02 0.0000e+00 2.1800e+00 0.0000e+00 4.5800e-01 6.9980e+00
 4.5800e+01 6.0622e+00 3.0000e+00 2.2200e+02 1.8700e+01 3.9463e+02
 2.9400e+00]     33.4
[6.9050e-02 0.0000e+00 2.1800e+00 0.0000e+00 4.5800e-01 7.1470e+00
 5.4200e+01 6.0622e+00 3.0000e+00 2.2200e+02 1.8700e+01 3.9690e+02
 5.3300e+00]     36.2
[2.9850e-02 0.0000e+00 2.1800e+00 0.0000e+00 4.5800e-01 6.4300e+00
 5.8700e+01 6.0622e+00 3.0000e+00 2.2200e+02 1.8700e+01 3.9412e+02
 5.2100e+00]     28.7
[8.8290e-02 1.2500e+01 7.8700e+00 0.0000e+00 5.2400e-01 6.0120e+00
 6.6600e+01 5.5605e+00 5.0000e+00 3.1100e+02 1.5200e+01 3.9560e+02
 1.2430e+01]     22.9
```

对数据进行拆分，测试集比例test_size=0.2

```
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.2)
```

二、算法

共采用三种regression算法

Linear Regression

目标函数：

$$h_\theta(x) = \sum_{i=0}^{n} \theta_i x_i = \theta^T x^{(i)}$$

Loss Function: 最小二乘法

$$J(\theta) = \frac{1}{2} \sum_{i=1}^{m} (y^{(i)} - \theta^T x^{(i)})^2$$

采取梯度下降算法，求出使误差最小的参数，则得到最终模型

Ridge Regression

加入L2正则项来调优模型。下面是Ridge Regression的损失函数;

$$J(\theta) = \frac{1}{2m} \left[\sum_{i=1}^{m} \left(h_\theta\left(x^{(i)}\right) - y^{(i)} \right)^2 + \lambda \sum_{j=1}^{n} \theta_j^2 \right]$$

Lasso Regression

加入L1正则项来调优模型。下面是Lasso Regression的损失函数;

$$J(\theta) = \frac{1}{2m} \left[\sum_{i=1}^{m} \left(h_\theta\left(x^{(i)}\right) - y^{(i)} \right)^2 + \lambda \sum_{j=1}^{n} |\theta_j| \right]$$

三、模型：

LinearRegressionPred函数

参数：训练集数据、训练集标签、测试集数据、测试集标签

选择LinearRegression训练模型拟合训练集，再用拟合得到的模型去预测x_test对应的价格

最后计算预测值与实际值的差距，分别计算MSE,MAE，并返回

```
def LinearRegressionPred(x_train,x_test,y_train,y_test):

    model = linear_model.LinearRegression()      #选择模型
    model.fit(x_train,y_train)      #拟合
    y_pred = model.predict(x_test)  #预测

    loss1 = mean_squared_error(y_test, y_pred)        #计算损失函数
    loss2 = mean_absolute_error(y_test, y_pred)

    return loss1,loss2
```

RidgeRegressionPred, LassoRegressionPred函数

与LinearRegressionPred的唯一区别在于选取的模型不同

```
def RidgeRegressionPred(x_train,x_test,y_train,y_test):
    model = linear_model.Ridge()    #选择模型
    model.fit(x_train,y_train)      #拟合
    y_pred = model.predict(x_test)  #预测

    loss1 = mean_squared_error(y_test, y_pred)        #计算损失函数
    loss2 = mean_absolute_error(y_test, y_pred)

    return loss1,loss2

def LassoRegressionPred(x_train,x_test,y_train,y_test):
    model = linear_model.Lasso()    #选择模型
    model.fit(x_train,y_train)      #拟合
    y_pred = model.predict(x_test)  #预测

    loss1 = mean_squared_error(y_test, y_pred)        #计算损失函数
    loss2 = mean_absolute_error(y_test, y_pred)

    return loss1,loss2
```

主程序：

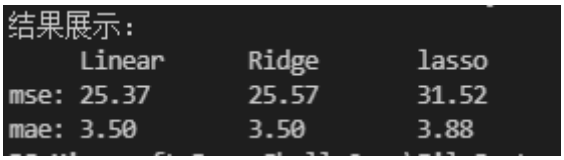
为了防止划分不同带来的结果误差，设置测试次数testNum=10，共进行10次实验

每次实验对数据集进行划分，并依次调用上面三个函数，得到测试结果

最后得出10次实验误差的平均值

```
for i in range(testNum):
    x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.2)
    t1,t2 = LinearRegressionPred(x_train, x_test, y_train, y_test)
    mseLinear+=t1
    maeLinear+=t2

    t1,t2 = RidgeRegressionPred(x_train, x_test, y_train, y_test)
    mseRidge+=t1
    maeRidge+=t2

    t1,t2 = LassoRegressionPred(x_train, x_test, y_train, y_test)
    mseLasso+=t1
    maeLasso+=t2

print("结果展示：")
print("     Linear      Ridge       lasso")
print("mse: %.2f       %.2f       %.2f "%
(mseLinear/testNum,mseRidge/testNum,mseLasso/testNum))
print("mae: %.2f        %.2f        %.2f "%
(maeLinear/testNum,maeRidge/testNum,maeLasso/testNum))

```

四、实验结果



三种算法中，Linear Regression, Ridge Regression得到预测结果最好，MSE为25.37、25.57，MAE为3.50、3.50

Lasso Regression的预测结果最差，MSE为31.52, MAE为3.88